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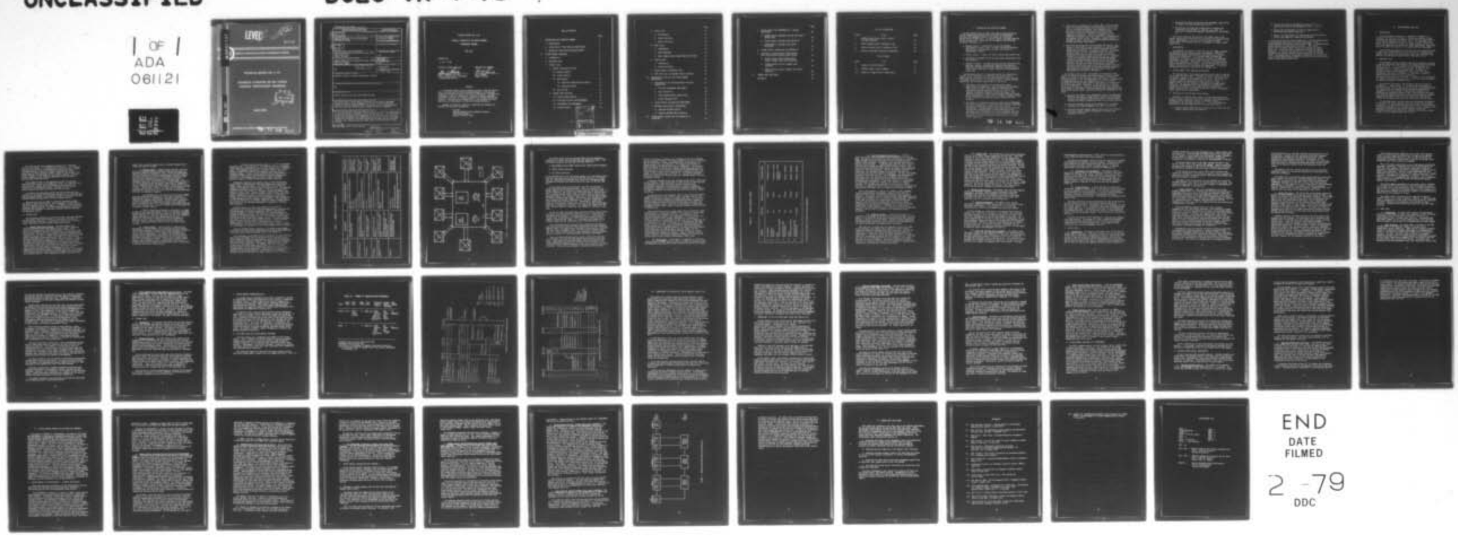

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TECHNICAL REPORT NO. 4-78

TECHNICAL OVERVIEW OF THE SYSTEM CONTROL IMPROVEMENT PROGRAM

MAY 1978

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20. ABSTRACT (*Continue on reverse side if necessary and identify by block number*)

The document describes plans for improving the DCS System Control capabilities to react efficiently to peacetime, crisis and wartime needs. The plans focus on improving the theater level management control and operational direction capabilities; upgrading the switched network and traffic controls; providing integrated utilization of the ADP capabilities throughout the system control hierarchy; and interfacing the DCS System Control with planned DCS II subsystems.

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TECHNICAL OVERVIEW OF THE SYSTEM CONTROL

IMPROVEMENT PROGRAM

MAY 1978

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FOREWORD

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I. INTRODUCTION AND EXECUTIVE SUMMARY

The DCS system control provides the primary means whereby the Defense Communications Agency (DCA) exercises its operational direction and management control over assets of the Defense Communications System (DCS). The system control subsystem comprises the DCS system control resources which accomplish the following functions (reference /1/):

- Network control - transmission and switched network configuration control; which includes network and extension supervision, reconstitution, restoral, and satellite configuration control.

- Traffic control - control of traffic routing and traffic flow.

- Performance assessment of the DCS and status monitoring of the DCS resources.

- Technical control - includes quality assurance and monitoring, patching, testing, coordinating, restoring and reporting functions necessary for effective technical supervision and control over trunks and circuits traversing or terminating in a facility.

The DCS system control is structured within five hierarchical control levels. Reference /1/ describes the system control objectives and allocates the roles and responsibilities to each of the system control levels. In evaluating means of achieving these objectives, the following factors must be considered:

- Exploitation of available and planned system control capabilities and resources. These include various automatic data processing (ADP), person/machine interfaces and information exchange capabilities that are (or will be) inherent throughout the system control hierarchy. The World-On-Line System (WWOLS), the Automated Technical Control (ATEC) improvement, and the DSCS Pilot Control System followed by the full Real Time Adaptive Control (RTAC) are a few examples.

- The impact of a subsystem technology and design on Management and Control procedures. Planned DCS communications subsystems are being designed and deployed to achieve greater availability. Technology has brought about more reliable and maintainable subsystems which contain redundancies and automated control functions for critical subsystem functions. This trend will undoubtedly impact the monitoring, testing, reporting and control procedures associated with the system control subsystem.

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- Exploitation of automation to maintain O&M levels and costs. There is a constant pressure to save O&M costs even in the face of increased operational loads stemming mainly from a multitude of service offerings and a growing resource allocation flexibility associated with switching and transmission resources. The use of automation and the remoting of functions can play a vital role in keeping costs and manpower levels at bay. Automation, however, must be weighted to assure appropriate balance between peacetime and wartime operational requirements.

- Operation and maintenance of distributed ADP systems. The advent of ATEC, RTAC and other automated (or semi-automated) systems will proliferate ADP elements throughout the DCS system control hierarchy. Coexisting with the current WWOLS resources there will be a multitude of ADP facilities operating with extensive and distributed data bases and interacting to achieve common operational goals. Operations in such an environment must maintain minimum operational complexity, minimum operator special skills and minimum operator dependence of detailed familiarity with subsystem functions and user behavioral patterns and tolerances. Efficient maintenance, support and administration of the ADP facilities and a capability to fall back to manual operation when necessary are another important factors which are prerequisite to successful operations.

The planned System Control improvements as described in this report, are geared to enhance the responsiveness of the DCS system control to crises and wartime needs, while attaining efficient peacetime operation. DCS reconfiguration and recovery, restructuring of fragmented facilities, and responding to Joint Multichannel Trunking and Switching Systems (JMTSS) requirements are examples of the former requirement. Automation or semi-automation of routine manual functions such as reporting, monitoring and fault-isolation are examples of the latter. The improvements under consideration are based on the system control objectives expressed in reference (1) and entail:

- Upgrading the theater level management control and operational direction functions by expanding the capabilities to process, correlate and present to the controllers for decision making relevant and timely information derived from multiple sources.

- Providing improved back-up to the theater level to assure continuity of timely management and control activities.

- Upgrading switched network controls and improving utilization of circuit switch resident information for control and management functions.

- Enhancing the WWOLS ADP and data base management capabilities to support ADP based systems such as ATEC.

- Defining and providing the system control interface and interaction with planned DCS projects, e.g., DSCS III, terrestrial transmission upgrades, AUTOSEVOCOM II and AUTODIN II.

This report describes the functions and capabilities of the present system control hierarchy and then defines the planned system control improvements as well as certain alternatives under consideration for achieving material improvements in System Control Capabilities.

1. ORGANIZATION

The remainder of section I identifies the time frame, approach, and objectives of the system control improvements. Section II describes the general characteristics and operations of the DCS system control hierarchy. It is largely based upon material presented in references /1/ through /12/. Section III summarizes improvements to system control capabilities as they apply to the present DCS subsystems. References /10/ through /13/ provided the major contribution to this section. Section IV identifies system control interaction with the planned DCS subsystems. It utilized information contained in references /14/ through /16/.

2. SYSTEM CONTROL TIME FRAME AND APPLICATION

The system control improvements described herein apply to the DCS of the 1980-1985 time frame. Consequently, these relate to existing and imminent communications subsystems of the DCS. The focus is on incremental upgrades to the present system control capability to provide a degree of improvement in data acquisition, data communications, and data processing throughout the system control hierarchy. The upgrades involve integrated use of present and planned System Control ADP and communications resources and capabilities which will also serve as the foundation for satisfying future system control requirements.

3. OBJECTIVES OF THE EVOLVING SYSTEM CONTROL

Reference /1/ defines system control as "the means whereby DCS assets are used to maintain and restore maximum DCS performance under changing traffic conditions, natural or man-made stresses, disturbances, and equipment disruptions." It also delineates the objectives of the DCS system control which are summarized as:

- Assure critical subscriber service and system connectivity and promote communication survivability.

- Provide the structure and means to support effective operational direction and management control of the DCS.

- Enhance the effectiveness of existing communications facilities and manpower resources.

- Support the requirements for interoperability with tactical, allied, and commercial communications systems.

In crises and wartime the primary objective of the DCS System Control is fast response and reaction to JMTSS extensions; and to reconfiguration, reconstitution and restoral needs. In peacetime the primary objective is operational efficiency. The current capabilities of system control do not fully satisfy the above objectives. These are based on technology designed for manual operation. As a result the operation is man-intensive, and its procedures are aimed at manually feasible response and reaction times. The System Control improvement program goal is to align the system control operational procedures and reaction time with current, proven, technological capabilities.

II. SYSTEM CONTROL SUBSYSTEM

1. INTRODUCTION

The system control structure, as defined in reference /1/, consists of a five-level hierarchy. The top two echelons of the hierarchy, the worldwide and theater levels, are the responsibility of the Defense Communications Agency (DCA). The remaining three levels, termed the sector, nodal, and station levels, satisfy both DCA and the Operation and Maintenance (O&M) requirements. These lower levels are under the auspices of a cognizant Military Department.

The following paragraphs describe the functional responsibilities of each level of the hierarchy, focusing on current worldwide and theater level capabilities at the upper levels and projected, ATEC enhanced, system control capabilities at the lower levels.

2. WORLDWIDE LEVEL

The worldwide level of the DCS System Control hierarchy consists of the DCA Operations Center (DCAOC), its associated data processing center and staff. It is collocated with DCA headquarters in Arlington and it is manned 24 hours per day, 365 days per year. Worldwide control is exercised at the DCAOC. The DCAOC in conjunction with the DCA headquarters staff ensure the timely, satisfactory resolution of problems of a persistent, unusual or complex worldwide nature which may impact the survivability/availability of the DCS. The DCAOC is also responsible for directly overseeing the operational direction of the DCS within the Western Hemisphere (A Theater level).

The specific functions of the worldwide level are listed in reference /1/. They include: (a) direction and coordination of worldwide control actions and specified services to designated users; (b) coordination with agencies having worldwide communications responsibilities (JCS, MILDEPS, International Carriers); (c) performing and publishing periodic status and performance analysis; (d) informing commands and agencies of serious disruptions to their communications capabilities; (e) providing traffic and network control and developing and publishing centralized restoral plans.

The worldwide level receives status and performance information on the major DCS systems and high interest circuits and maintains awareness of (a) major network troubles and failures and significant performance degradation; (b) switched network traffic congestion; (c) hazardous conditions and persistent equipment outages and malfunctions; (d) major control and restoral action taken at lower levels; (e) total network trends and factors.

The DCAOC employs both automated and manual data reduction, analysis and display. It is supported by interactive CRT terminals with hard copy printers, teletypewriters, and voice communications. Considerable usage is made of a hubbed teletypewriter system connecting the Area Operations Centers (ACOC) for the European and Pacific theaters to the DCAOC and its support elements. The hubbed teletype network allows informal communication and information sharing among these facilities.

Voice communications in the Operations Center include both commercial and 2- and 4-wire AUTOVON facilities. The two-digit dial voice orderwire systems used by AUTOVON and AUTODIN operators terminate in the Operations Center. Ringdown circuits to AT&T control centers and other facilities are also provided.

In addition, the Operations Center has CRT displays and line printers for accessing and retrieving information from the supporting data processing system. The Operations Center also receives via the AUTODIN network teletypewriter listing of status reports.

Data processing at the DCAOC is currently supported by dual IBM-360/30's and an IBM-370/145. These computers form the heart of the World-Wide On-Line System (WWOLS). The WWOLS is interconnected using the AUTODIN network. The data processing portion of the DCAOC maintains the worldwide DCS data base, performs trending analyses, and generates reports.

3. THEATER LEVEL

The following paragraphs describe the primary functions provided by each theater level activity and, in most cases, the means of fulfilling these functions. Functions are described to a level of detail sufficient to indicate their nature and purpose.

a. Theater Operations Activity. Overseas theater level operations activities are the responsibility of the European and Pacific Area Communication Operations Centers (ACOC). The operational direction function is performed on a 24-hour basis 365 days per year. Non-critical operational assistance to activities is limited to the day staff. Theater level functions pertaining to the Western Hemisphere are performed by the DCAOC as a subset of its worldwide DCA Operations Complex Center (DOCC) functions. Presently the ACOC controllers are supported by: critical control circuit teletypes from AUTOVON and AUTODIN sites; an AUTOVON Centralized Alarm System status board; an AUTOVON Traffic Data Collection System (TDCS) unit; a critical control circuit to the satellite earth stations with Spectrum Analyzer; telephones for both verbal communications and direct control of AUTOVON switches; a CRT terminal and printers which are interactive with the WWOLS; and various maps and reference sources. These supporting elements provide varying

capabilities to perform network control, switched network/traffic control and satellite control.

(1) Network Control. Network Control basically views the DCS as a connectivity matrix determined essentially by nodes and associated connecting transmission links. Unlike the transmission control function which maintains communications capability between two points, primarily by one-for-one replacement activity at the sub-link level, network control is dedicated to maintaining communications capability throughout the connected nodes. The subsequent repair and return to service is a maintenance function of the serving Operations and Maintenance (O&M) Agency or commercial carrier, depending whether government owned or leased facilities are involved. The addition of users, facilities, and services to the DCS is also a network control function, but one which is presently performed on a routine basis as a Staff Activity and by an Operations Activity in an emergency situation.

The determination of an effective restoral plan depends upon preplanned Centralized Restoral Plans (CRP), an accurate knowledge of the users' communications requirements and a current status of the communications network. The CRP's enable recovery of the most fundamental DCS communications capabilities, especially those resulting from the loss of links between concentrated areas and the loss of network nodes. The CRP's provide nominal plans which can be modified as events require.

The 55-1 Reporting as defined in reference /5/ is based on time thresholds geared to manual control and reporting procedures. Neither the near-real-time narrative reports nor the daily formatted reports submitted for historical statistical analysis are designed to support ADP aided near-real-time network control activity. An exception is the AUTODIN I reporting function which generates near-real-time 55-1 reports concerning tributary access lines (U-line), interswitch circuits (IST) (K-line), and switch status (S-line).

(2) Traffic Control. Traffic Control is concerned with maintaining a critical traffic flow through the available network. The network is engineered to meet service objectives such as Grade of Service (GOS) and Speed of Service under normal conditions for various traffic requirements. For example, the AUTOVON trunking grade of service objectives are according to JCS non-blocking for worldwide flash traffic, P-03 within CONUS, P-03 for most overseas and P-10 for transoceanic traffic. In the event of traffic surges, unusual traffic patterns or loss of communications facilities, traffic control must be capable of altering the traffic flow patterns to maintain end-to-end critical traffic.

Traffic Control involves control of traffic flow between switching nodes, links and users. The switches provide the network intelligence and, consequently, most traffic controls are implemented there. The management and control of traffic flow in the network requires visibility of traffic flow patterns and total network resources status. Traffic control decisions are a responsibility of the ACOC and DCAOC within the constraints of the NCS restoration priorities. The implementation of traffic control decisions generally requires current information and timely execution.

Information regarding the present status of AUTODIN Switching Centers (ASC) is maintained at the Area Communications Operations Centers (ACOC) and the DCAOC. This information is received via automatic and manually prepared reports from the ASC's. The reported information includes volume of traffic in the ASC, message traffic backlog, status of ASC hardware, software, interswitch trunks, and tributary access lines. Reports covering traffic volume (including number of messages in queue, in overflow storage, on intercept storage, and in off-line recovery) are reported at 2-hour intervals, or when unexpected traffic volumes cause backlogs. The remainder of the reports are sent on occurrence. Data for traffic volume reports are available to ASC operating personnel by requesting a "switch STAT" printout.

AUTODIN controls currently exercised are (see Table I): alternative trunk routing for altering message paths; altrouting for routing messages to alternate addresses; traffic intercept for routing messages to storage; trunk holds for routing messages to storage at adjacent switches; and inhibiting entry into AUTODIN for preventing or limiting network access. All of these controls are activated from the local switch system console. The switch operator may decide on a course of action involving some of these controls. However, approval by the ACOC is required prior to control implementation. The ACOC can also initiate control actions by means of a teletypewriter connection to the switch system console operator.

Overseas AUTOVON network visibility is provided to the AUTOVON controller at the ACOC by the AUTOVON Central Alarm System (ACAS) and the Traffic Data Collection System (TDCS). (See Figure 1.)

ACAS interfaces the AUTOVON switch and monitors the status of the major switch subsystems for out-of-service (O/S) indication of the switch memories, logic units and markers, and the switch comparator mode of operation (Automatic/Manual). The system monitors indicators of traffic level conditions. For example, DTMF receivers, MF 2/6 transceivers and trunk groups are monitored for busy condition. Register Sender Junctor (RSJ) status and Line Load Control (LLC) implementation are also monitored. The monitors are scanned every 2 seconds and corresponding data is transmitted over a dedicated teletype circuit to the ACOC for visual display (light indicators).

TABLE I. SUMMARY OF AUTODIN CONTROLS

AUTODIN Control	Description	Conditions When Employed	Network Impact
Alternate Trunk Routing	Alter Paths Followed by Messages by Modifying TDW's	High Traffic Volume at ASC Destined to Other ASC's ASC Failures Trunk Failures	Shifts Traffic from Overutilized to Underutilized Network Elements
Traffic Intercept	Route Messages to IC Storage Tape Upon Directions from Console Operator	Tributary Line Outage High Traffic Volume at ASC Destined for Tributaries	Removes Traffic from Network
Trunk Holds	Route Messages to IC Storage Tape at Neighboring ASC's	ASC Failures High Traffic Volume at ASC (Inter- and Intra-Switch Traffic)	Removes Traffic from Network
Altrouting	Route Messages to Alternate Addresses	Tributary Line Failures	Removes Traffic from Network
Inhibiting Entry into AUTODIN	Transmit WBT Signals to Selected Terminals to Prevent Network Access Transmit MINIMIZE Message to All Users to Discourage Low Priority Traffic	High Traffic Volume throughout Entire Network Highly Degraded Network	Reduces Level of Incoming Traffic
Patching	Adding Additional Circuits for Use as Tributary Access Lines or Interswitch Trunks	ASC Failures Trunk Failures Tributary Access Line Failures High Traffic Pressure Over Specific Circuits Over Long Period of Time	Removes Traffic from Network (by Enhancing Network Capacity)

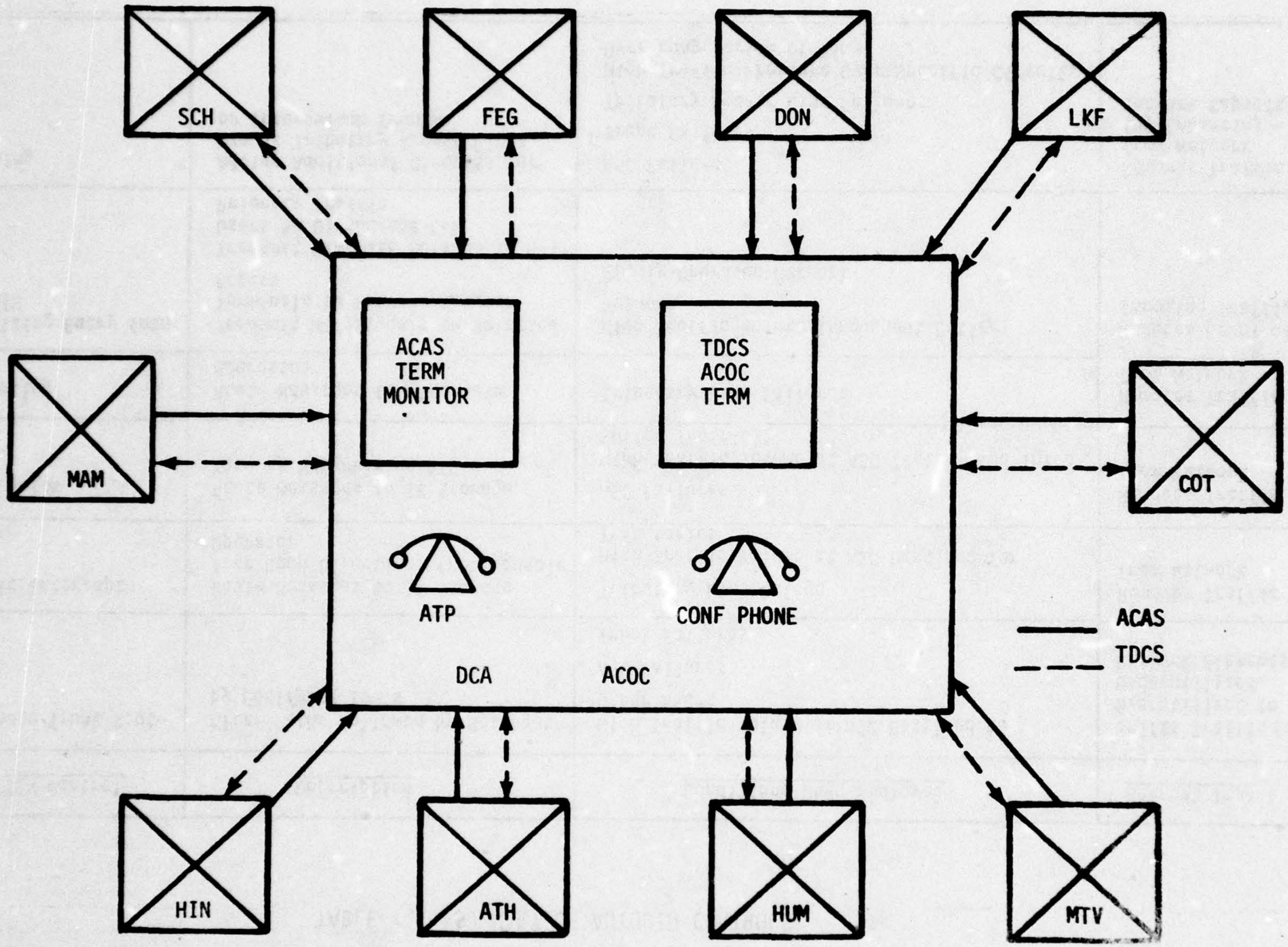

Figure 1. VON Switch System Traffic Control (European Theater)

The Traffic Data Collection System (TDCS) provides automated collection of traffic and call data from the AUTOVON switches. TDCS interfaces the switch and provides three key functions:

- Rapid Memory Reload (RMR) function for loading switch program.
- Traffic Data Collection.
- Call Data Collection.

At the AUTOVON switch site the system supports only one function at a time and interrupts ongoing function when RMR function is initiated. TDCS has communications features which allow for simultaneous data transmission from two TDCS Switch Site Units (SSU) to the ACOC TDCS Unit.

In the traffic data collection mode, the TDCS SSU collects traffic data during scheduled periods. Data is collected in a 60 minute interval and it consists of usage, duration and count data. A special feature of the traffic data collection mode is the provision of a 15 minute special study to help to assess network traffic and equipment status. This option provides for a local and ACOC printout of up to 20 selected data items. This study can be started and the data returned to the ACOC telephonically. The data automatically prints on the TDCS receive only TTY. Additionally, during the exercise of the option, single counts of any of the 2000 long format items may be obtained by the ACOC. This reporting, though after the fact, is the closest to a near-real-time capability featured in the TDCS.

In the call data collection mode, the TDCS collects data on calls originated by local subscribers and data on calls to Dial Service Assistance (DSA) operators. The data consists of: connection and release time, originating and terminating trunk numbers, called numbers, precedence and route. It is obtained from readout of the register sender junctor information used in processing the call.

TDCS long format traffic and call data collected at the switch site are processed through the TDCS miniprocessor and then stored on magnetic tape. This data can be retrieved electronically by the ACOC TDCS and stored on magnetic tape. The data can be printed on the TDCS TTY. The call data can be further analyzed by IBM 360 computer analysis programs for long term network performance assessment.

There are other valuable sources of call disposition data and circuit status available from the AUTOVON switch at the local site only. These sources include the trouble reports generated by the switch diagnostic subsystem and individual circuit (access line or interswitch trunk) status reflected at the switch make busy facility, TR-05 Bay. The wired logic diagnostic subsystem provides trouble

reports on failures to process calls through the switch or network, and on equipment failures. The output product is an IBM card from an IBM 026 card punch. Although the diagnostics are automated, the output product (IBM card printout) is in coded form and must be manually decoded for meaningful trouble information. For the most part, this data is used to fault-isolate switch subsystem equipment failures, but it also indicates transmission related problems. The status of each circuit (Idle, Busy and Out of Service) is reflected visually at the switch make busy facility. The AUTOVON Secondary Board also reflects the status visually of PBX/PABX access lines and interswitch trunks.

In general, AUTOVON switch data received at the ACOC is event and function related. Data correlation to other events or functions and to information received from other switches and associated transmission subsystem is confined mostly to manual procedures. Consequently, despite the large amount of available relevant data, the lack of resources to process the data limits the overall network visibility.

Through the use of the Automatic Traffic Phone (ATP) the AUTOVON network controller can dial traffic plans into each switch in the network to alleviate stresses or degraded conditions. A conference phone provides direct simultaneous communications with switches to validate status and coordinate traffic plans before and after the dialing of traffic plans. There are no provisions for displaying implemented traffic plans either at the ACOC network control position or switch sites.

Aside from dialing traffic plans which involve relatively simple routing control, the primary AUTOVON controls which can be directed from the ACOC (see reference /7/) are: (a) Automated Traffic Overload Protection (ATOP) which implements line load control (LLC) based on register-sender junctor availability; (b) manual LLC directed singly or in combination to deny dial tone to immediate (LLC A), priority (LLC B) and routine (LLC C) - these provide the same capabilities as the ATOP; (c) Preengineered AUTOVON Restoral (PAR) which provides plans for bypassing critical subscribers around a failed switch onto an operating switch; (d) trunk directionalization which classmarks IST from two-way to one-way trunks; and (e) destination code cancellation which inhibits traffic to a given switch because of outage or isolation. Table II depicts existing traffic controls, the resource which they impact, and the mode and system control level at which implementation takes place.

(3) DSCS Control. DSCS control is comprised of satellite communications (SATCOM) control (control of satellite accesses, power and bandwidth) and satellite control (controlling satellite systems).

TABLE II. TRAFFIC CONTROL SUMMARY

CONTROL	EXISTING	NETWORK RESOURCE	IMPLEMENTATION
1. Preemption	Yes	Trunks	Automatic, Local
2. Alternate Routing	Yes	Trunks	Automatic, Local
3. ATOP (Line Load Control)	Yes	RSJ	Automatic, Local (Manual)
4. Destination Code Cancellation	Yes	Trunks*	Manual, Network
5. Trunk Directionalization	Yes	Trunks*	Manual, Network
6. Alternate Routing Cancellation	Limited	Trunks	Manual, Network

* Can also be used to relieve switch congestion

(a) Satellite Communications Control. The DSCS satellite accesses are controlled by the SATCOM controller at the ACOC. Monitoring of the satellite down-link spectrum is achieved via HP8580 Automatic Spectrum Analyzers located at designated DSCS monitor earth terminals. The HP8580's are accessed and controlled remotely from the ACOC's. Communications with the earth terminals are provided by hubbed teletype critical control circuits. The control system has recently been adapted to control four operational satellites, two from each ACOC. There, the SATCOM Controller is responsible for the establishment of satellite links and for maintaining the satellite networks performance. As such, the SATCOM Controller activities include: (a) computation and evaluation of performance data, (b) determination of jamming condition and implementation of the spread spectrum multiple access links, (c) maintenance and adjustments of link power margins, (d) maintenance and adjustment of satellite loading, (e) isolation of network troubles, (f) implementation and monitoring of special users' accesses, (g) update of system status, (h) preparation of reports and coordination with DCAOC, and (i) scheduling of terminal downtime.

Future enhancements in control are needed to meet expanding digital communications requirements, control of the DSCS III spacecraft, and control of the next generation spread spectrum accesses. An enhanced control system, the Real Time Adaptive Control (RTAC) (see reference /14/), is currently being developed. RTAC will allow links to operate at reduced margins, increasing the DSCS capacity, and will provide current DSCS data base and status information for operation and management at all levels of control (DCAOC, ACOC, earth terminals). Concepts for future control techniques are being tested as part of the Pilot Control System test program. The full RTAC is planned to be implemented by the mid-1980's.

(b) Satellite Control. Control of the DSCS II satellites is performed by the Air Force Satellite Control Facility (AFSCF). The AFSCF has single-point contact with the DSCS control through an orderwire with the DCAOC. The ACOC (SATCOM controller) through the DCAOC coordinates with the AFSCF on reconfiguration of the satellite antennas and communications subsystem.

When the DSCS III satellites are deployed, the DCA will have direct telemetry and command (T&C) capability through ground equipments located at selected DSCS earth terminals. DCA will be authorized to control the satellite antenna configuration and communications subsystems, while the AFSCF continues to perform satellite housekeeping, tracking and orbit determination. Both DCA and AFSCF will be equippped fully for all telemetry and command functions to serve as backups. Performing Telemetry and Control functions is driven by the need for quick response to jamming and to increase the survivability of satellite control.

(4) Back-Up ACOC. The current DCS system control hierarchy provides only limited back-up capability for the ACOC. Individual elements of the overall ACOC responsibilities are temporarily assigned to lower system control levels. In the European theater, Croughton facility assumes responsibility for the AUTODIN network, Hillington facility assumes control for the AUTOVON network and the Landstuhl facility assumes the satellite control functions. At DCA SWP and DCA NWP, Regional Control Operations Centers provide various but limited degrees of back-up capability for the Pacific ACOC AUTODIN and AUTOVON network control functions. Satellite control reverts to DSCS Sunnyvale. In the back-up mode 55-1 reports are submitted in the normal manner and are routed to the appropriate facility through Contingency Alternate Routing Program (CARP) action. Data base maintenance is assumed by the other WWOLS sites, i.e., DCAOC or the DECCO facility. In all cases the back-up facilities provide only the very basic manual coordination and direction. These facilities provide no consolidated view of the theater resources and networks. Nor do they possess the displays, data base access, processing and control features associated with the ACOC.

b. Theater Staff Activity. The theater functions which support operational direction include resource management, data base management, contingency plan management and system analysis. Although these functions are generally performed as long range activities, the near-real-time system control activities are dependent upon the contingency plan effectiveness.

(1) Resource Management. The theater level has the centralized responsibility for administration of the assets of the DCS within that theater. This responsibility includes the administration of facility assignments and authorized outages.

Circuit changes are initiated by a Telecommunications Service Request (TSR) submitted by the user to the theater staff activity. The staff develops a set of Telecommunication Service Orders (TSO) which when implemented satisfy the requirements of the TSR. The circuit engineering of the TSR is aided by the implementation of the semi-automated Computer Assisted Circuit Engineering and Allocation System (CACEAS). CACEAS is steadily being improved as an internal activity within DCA. Since this activity is dependent upon an accurate data base, the data base management function is a key aspect of improved control and management for the DCS.

(2) Data Base and Data Base Management. The theater level data base contains the data depicting theater level connectivity and the assets supporting this connectivity. Access to this data base is currently available by means of CRT/printer terminals located at selected DCA and MILDEP sites around the world. The data base can be accessed using AUTODIN terminals validated for this use and is also available on a computer-to-computer basis within WWOLS. The Data

Base Management System employed is TOTAL which has been available on a wide range ADP applications and processors.

The data base management system include the capability to specify both immediate and projected data base changes. Projected changes can be entered into the theater data bases as a non-real-time activity upon receiving a manual in-effect report. A detailed description of the data base is provided in reference /4/.

(3) Contingency Plan Management. Contingency plans or Centralized Restoral Plans (CRP) are another function of the staff elements which support the primary objective of system control to assure critical subscriber service and system connectivity. The development of CRP's employs the same data base as the TSR/TSO process; however, when implementation of a CRP becomes necessary, manual checking is required to insure availability of planned resources.

(4) System Analysis. A system analysis activity which establishes system performance profiles and assists in the resolution of subtle problems is also provided. This non-real-time function which considers the interdependencies of various system performance parameters requires centralization of supporting data and a considerable computing capability. This function is performed at the theater level.

The data correlation function associated with the system analysis activity generally requires raw data and high visibility of potentially related events. Performance data is accumulated from the 55-1 status reports. It is processed at each ACOC to determine user and system impact and is forwarded to the DCAOC for the preparation of worldwide analysis. Each of the ACOC computer systems develops locally required performance reports. This is done as a low priority activity.

The data correlation effort represents a relatively new endeavor in system analysis. The present "Q" factor program at the theater level which provides performance profiles of the present analog communications links on the system level is an example of data correlation used to focus management attention.

4. SECTOR LEVEL

a. Introduction. The sector is the third level in the overall system control hierarchy. There are no sectors, as such, within the present DOCC or O&M control structures of the DCS. The sector level is most closely paralleled by O&M Facility Control Offices (FCO). Because of the wide dispersal of DCS transmission media throughout the Pacific Area some of the level 2 responsibilities assigned to DCA Pacific ACOC are shared with Regional Control Operation Centers at

DCA-NWP and DCA-SWP, which are designated level 2 DOCC elements (see reference /2/). Since the RCOC's maintain purview over areas that may correspond to sector areas close interaction between the RCOC's and the sector is required to facilitate direct coordination, cooperation, and sharing of resources for the management of the DCS.

The sector reports both to the ACOC (through the RCOC in the Pacific Theater) and to the parent O&M command. Separate reporting procedures are provided to the DCA and the O&M agencies reflecting the particular responsibilities and needs of these organizations.

In the present structure, sector (FCO) level activities are limited to coordination of transmission restoral actions, generally above circuit level, processing reports from reporting stations, and providing technical direction.

The capabilities of the sector will be expanded as a result of the ATEC program. Each sector will supervise up to five nodes. The location of the sectors will be based on a number of considerations which are enumerated in reference /9/.

b. Sector Functions. When fully implemented via the ATEC program, sectors will: (a) overview and coordinate the transmission subsystem control activities, (b) process and transfer status and performance information to the most immediate theater level from all control elements reporting via the ATEC's communications facilities, (c) relay control directives from the most immediate theater level to all subordinate control elements interconnected via the ATEC communications facilities, and (d) temporarily back up or participate in backing-up of the ACOC.

While the immediate theater level will retain primary responsibility for controlling the theater DCS transmission systems, sectors will have the responsibility to direct and coordinate fault isolation and restoral actions involving multiple link configurations within the theater. Using the ATEC communications facilities, reporting will proceed from stations to nodes to sectors, with the lower levels furnishing status, test and performance data and the sectors, in turn, providing coordination and direction. The sector level will also be interconnected via the ATEC communications facilities to other sectors within the theater to enable lateral inter-sector information exchange and coordination.

References /8/ and /9/ describe the sector functions associated with transmission subsystem control. These functions include performance assessment, generation of parameter history, reporting and displays, generation and transmission of status reports according to DCAC 310-55-1 procedures, status and performance correlation, validation and coordination of restoral plans, and fault assessments and isolation. The sectors are responsible for maintenance control

and distribution of all the ATEC required data base which will be unclassified. Theater-wide DCS connectivity and ATEC equipment configuration information, plus the sector-wide ATEC to DCS connectivity and performance thresholds information, will be maintained in each sector's data base. The sector will coordinate with the theater in implementing Telecommunications Service Orders (TSO) and in updating restoral plans for selected circuits and trunks.

The theater level will furnish the sector (as yet not fully determined) support in loading and updating the unclassified ATEC data base information.

The sector will also provide system support functions other than those directly associated with Transmission/Network control. The sector will be used to process and reduce status and performance information generated by "non-ATEC" station level DCS reporting components. In this capacity, it will relieve some of the processing from the WWOLS components. For example, off-line performance analysis, trending and correlation of traffic congestions with link status within the sector can be performed at this level.

c. Sector Facilities. ATEC facilities at the sector level will be used to route system control message traffic among the ACOC's, the RCOC's, the sectors, and the sector subordinate elements. Up to seven 2400 b/s full duplex communications ports will be provided at the sector level for system control functions. One of these may be utilized to provide direct, on-line communications between the immediate theater level and the sector. The functional, physical and electrical requirements of these communications ports interfaces will be identical to those specified by ATEC. The sector will also be provided with a 2400 b/s full duplex synchronous interface with the AUTODIN network which will serve as the prime interconnection with the theater level elements.

Terminals identical to those procured by the ATEC system (with keyboards and CRT displays), are anticipated to be required at the theater level to interface with the system control unique functions at the Sector. These will be used in performing parameter administration, data base updates, status monitoring and operational coordination activities. In the case that a sector is designated to back-up the theater level Operation Complex, additional terminals would be required at the sector. These would be manned and operated by the sector personnel. The actual equipment deployment, the processing task load and organizational structure at a given sector will have to be considered in order to determine the number of terminals required for the aggregate functions of the sector.

The available moderate speed hard copy device (300 lines per minute) is anticipated to be sufficient to support the combined sector functions, administrative as well as the monitoring and coordination functions, during normal conditions or during crisis situations when routine tasks are preempted.

The sector level contains the unclassified theater connectivity data base. Additional information such as switched networks and satellite earth terminal configuration interconnects with the terrestrial transmissions and traffic performance parameters will be added to the data base. The disk storage requirement for this additional data base plus provision for unique system control support programs is estimated at 10 megabytes of storage. This will be backed up by an off-line magnetic tape storage of static information with a capability provided to transfer the information between magnetic tape and disk.

The primary memory requirement for the system control functions is a minimum of 50K 16-bit words for resident programs and tables, and an additional 16-bit word overlay area. The specification of an overlay area is intended to encourage a design of the programs and data base which minimizes the need for transfers to and from the disk memory during the execution of a task.

The system control functions are not expected to impose a sizeable burden on the sector processor. However, in the event that there is competition for the sector processing resources, processing of theater imposed directive messages will precede all other functions. Background and analysis functions will have the lowest priority.

5. NODAL LEVEL

a. Introduction. The nodal level controls and coordinates activities within several station level technical control facilities and provides access to the upper hierarchical levels via an interconnection with a primary sector facility. Interfacing with each nodal element are up to eight communications lines from ATEC station elements, one of which is collocated with the nodal element.

b. Nodal Functions. The nodal level, as defined in the ATEC configuration, is an essential element of the terrestrial transmission control capability. Under the ATEC concept, exception reports of transmission parameter measurements are automatically routed to the nodal level where they trigger the fault isolation activity. The fault isolation process involves an automated sequencing through a set of directed parameter measurements pertinent to the alarmed transmission equipment within the range of the node and the scope of the available ATEC assets. An operator then determines from the measurements taken, the responsible station level

facility and forwards the pertinent data to the Technical Controller. Coordination and fault isolation with other nodes are established through the sectors via 2400 b/s lines. Reference /8/ provides a detailed description of the nodal transmission and technical control related functions.

System control functions at the nodal level include coordination and review of TSO's by the node which has been designated Circuit Control Officer (CCO) or which has been assigned implementation of a segment of a TSO. Upon completion of the TSO these nodes will transmit and in-effect report back to the sector. After review and processing of the implementation date, an in-effect report will be routed to the theater level. At the theater level the in-effect report will trigger the activation and dissemination of the corresponding data base updates across the theater levels and worldwide level. The sector will disseminate the updated information to other sectors and affected subordinate levels.

Other functions primarily relate to data reduction, status maintenance, correlation of transmission related inputs for fault assessment, fault isolation, displays and information exchanges. The node will serve to reduce and correlate data collected from stations under its supervision. The implementation of this functional capability at the node will depend to a large measure upon the capabilities of the station's equipment to provide this function and will be determined on a case-by-case basis.

The nodal correlation function will relate information received from all applicable sources to determine the type and severity of reported disruptions. For example, an indication of loss of synchronization of an AUTODIN circuit will be correlated with the transmission input source which shows a degraded level. While the degraded level indication alone could not reveal if user service was impaired, the correlation would reveal the severity and thus help to establish the priorities for reaction to disruptions.

The nodal controller will be capable of controlling and directing assigned fault isolation activities. The fault isolation function will encompass both automated and manual capabilities and will take advantage of the proposed ATEC fault isolation routines.

The nodal processor will exchange information with the sector processor concerning all degradation, outages, reroutes and their subsequent restoral. This information is in support of the data base update. Status information pertaining to a station will be sent on request from station personnel or the nodal controller.

The control functions to be exercised by the node are associated with transmission fault isolation activities.

c. Nodal Communications Requirements and Facilities. The nodal level accommodates up to three 2400 b/s communications lines for system control needs. Also, as the ATEC station to nodal communication lines may in some cases be shared by system control data, the nodal level must also be capable of sorting out this information and forwarding it to the appropriate system control level. The nodal level will administer the data flow and will accommodate the ATEC data transfer protocol structure. The nodal memory requirements are estimated at 4M bytes for bulk memory and 50K primary storage with 40K overlay area. Its processing and throughput characteristics are similar to that of the sector. Aside from communications facilities, the nodal equipment will comprise a central processing unit and associated resident memory, disk and magnetic tape units, line printer, and nodal controller terminals.

6. STATION LEVEL

a. Introduction. The station level deals with the facilities of the DCS, and includes the Technical Control Facilities (TCF), Patch and Test Facilities, Satellite Earth Stations, the transmission equipment and the network switches. The station level can be considered as the lowest level of decision making. It provides the initial identification of degradation and the first step towards fault isolation. It is also the control level where directives (TSO, restorals, reconfiguration, etc.) are implemented.

b. Station Functions. The ATEC station level assets will be deployed in TCF's and Patch and Test Facilities and will provide semiautomated capability for in-service monitoring and out-of-service testing of both analog and digital transmission facilities and for sensing selected equipment alarms. The functions of the individual station level ATEC equipments collectively referred to as the Measurement Acquisition Subsystem (MAS) are delineated in reference /8/.

Station performed functions other than those directly related to technical control include unique functions associated with switches and earth terminal facilities. Reference /11/ provides examples of those functions, both manual and automated. Briefly, these functions include collection of major alarms, and on occurrence, performance and loading data. Local control actions will also be reported on a timely basis. Subscriber terminal status when determined by loop-back tests will be made available to the associated node.

The station will accept, acknowledge and implement both processor to processor and manually initiated commands and controls and data base updates originated from the Theater level.

7. SYSTEM CONTROL INFORMATION FLOW

The system control information flow which is required to satisfy the operational capabilities described in this section is summarized in Figures 2 and 3. Figure 2 depicts the flow of categories of information up through the system control hierarchy, and Figure 3, down through the hierarchy. The system control communications connectivity and capacity proposed to satisfy those information flow requirements are summarized in section VIII.

In Figures 2 and 3, the bars depicting the various information types show a flow from origin to destination within the hierarchy. A line in passing through a level, which also breaks out within that level, indicates coincident use by that level of the particular data. No breakout indicates that the data merely flows through that level. The termination end of a line indicates data is processed at the terminating level. The source of information is indicated by the originating point of the line. A dashed line indicates the data may or may not actually be routed through the indicated system control level. For example, AUTODIN I switch information is routed by the AUTODIN network to the ACOC's.

8. ATEC PROVISIONS FOR SYSTEM CONTROL FUNCTIONS

The ATEC Program will accommodate requirements of DCS system control. This is carried out via provisions for spares and growth communications capability, processor capacity, memory capacity (primary and bulk), and includes operator terminals and hard copy printers. Development of additional software is required to achieve functional capabilities otner than those associated with transmission and technical control functions.

The resources required at the sector and nodal levels for the additional system control capabilities are summarized below in Table III.

TABLE III. SUMMARY OF COMMUNICATIONS REQUIREMENTS

Level	Oper. Term.	Hard Copy	Comm Lines	Time Rate	Processor Capacity ****	Primary Memory (minimum)	Bulk Memory
Sector	2***	300*** lines/ minutes	6	2400 b/s	27000 instruc/ sec at 100% disk utilization **	50K Fixed 40K Over-lay***	10 Megabyte
Nodal	1	*	3	2400 b/s	14000 instruc/ 100% disk utilization **	50K Fixed 40K Overlay ***	4 Megabyte

*Irregular use, could be shared with ATEC
**Assumes 50 msec access time
***If Sector is designated as theater level back-up facility
****The processor capacity assumes worst case scenario described in reference /11/.

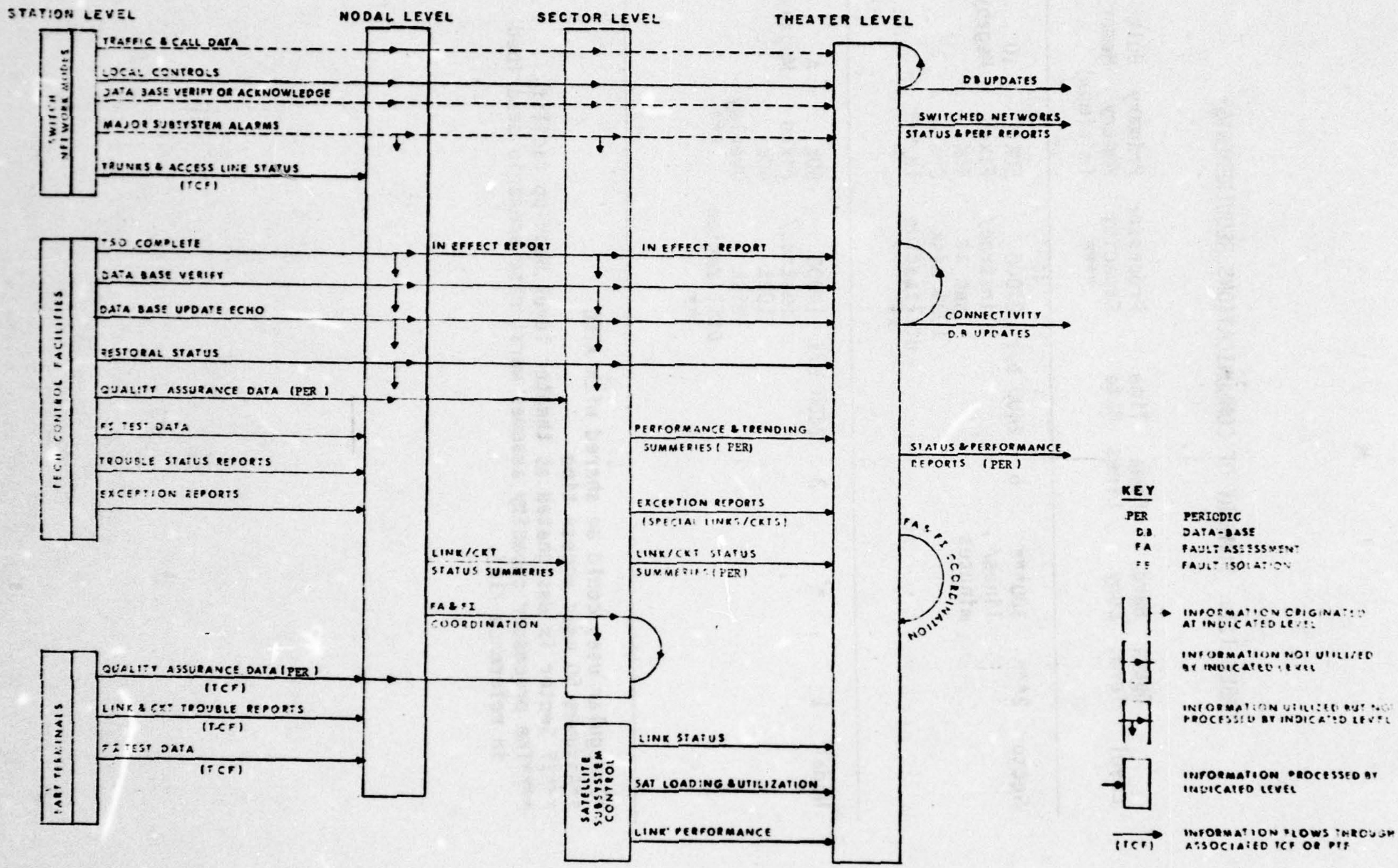

FIGURE 2

UPWARD SYSTEM CONTROL INFORMATION FLOW

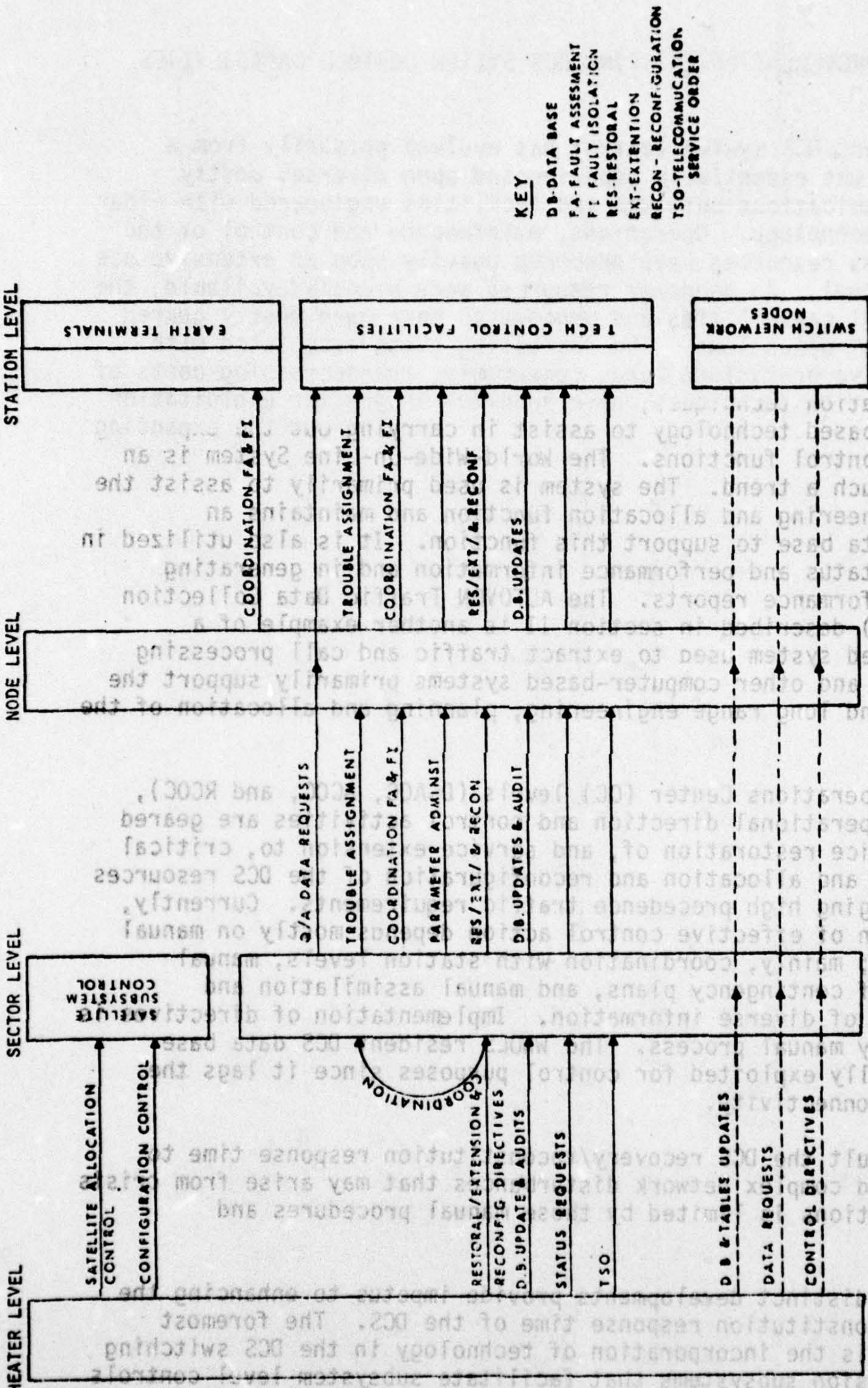

FIGURE 3
DOWNWARD SYSTEM CONTROL INFORMATION FLOW

III. IMPROVEMENT OF EXISTING DCS SYSTEM CONTROL CAPABILITIES

The present DCS system control has evolved primarily from a system which was essentially superimposed upon diverse, mostly analog, communications networks and facilities engineered with older generation technology. Operations, maintenance and control of the communications resources have depended heavily upon an extensive use of O&M personnel. As manpower resources were readily available, the system control capabilities and procedures have been mostly geared towards manual operations. The increasing costs associated with labor intensive operations, and, conversely, the decreasing costs of proven automation techniques, have resulted in greater exploitation of computer based technology to assist in carrying out the expanding DCS System Control functions. The World-Wide-On-Line System is an example of such a trend. The system is used primarily to assist the circuit engineering and allocation function and maintains an extensive data base to support this function. It is also utilized in processing status and performance information and in generating periodic performance reports. The AUTOVON Traffic Data Collection System (TDCS) described in section II is another example of a computer based system used to extract traffic and call processing data. These and other computer-based systems primarily support the management and long range engineering, planning and allocation of the DCS.

At the Operations Center (OC) levels (DCAOC, ACOC, and RCOC), short-term operational direction and control activities are geared towards service restoration of, and service extension to, critical subscribers; and allocation and reconfiguration of the DCS resources to meet changing high precedence traffic requirements. Currently, determination of effective control action depends mostly on manual interactions; mainly, coordination with station levels, manual validation of contingency plans, and manual assimilation and presentation of diverse information. Implementation of directives is also a mostly manual process. The WWOLS resident DCS data base cannot be fully exploited for control purposes since it lags the actual DCS connectivity.

As a result the DCS recovery/reconstitution response time to prolonged and complex network disturbances that may arise from crisis or war situations is limited by those manual procedures and operations.

Several distinct developments provide impetus to enhancing the recovery/reconstitution response time of the DCS. The foremost development is the incorporation of technology in the DCS switching and transmission subsystems that facilitate subsystem level controls to enable recovery, reconfiguration and interoperability. A case in point is the DCSC which is evolving with increasing flexibility to

dynamically manage and reallocate satellite resources in response to traffic requirements and stress situations. Similar capability to dynamically reallocate terrestrial digital transmission resources are also feasible. These subsystems employ automated local controls; semi-automated interfaces for exchanging management and control information including collection of status and performance data; and semi-automated, local and remote controller/machine interfaces supported in some cases by resident ADP and application software. As a result the response time for making and implementing control decisions will be enhanced not only at the local level but also at the Operations Center level. With the availability of timely status and performance data supported by processor based correlation and display functions a coherent system view of the DCS is needed for achievable control decision. A second development is the emergence of the ATEC system. The system can provide the communication and processing resources for exchanging and processing timely management and control information throughout the System Control hierarchy.

1. ENHANCEMENT OF THE DCS OPERATIONAL DIRECTION CAPABILITIES.

A major objective of the system control improvement program is to provide more effective means to control the DCS, especially in a crisis environment. The approach is to improve recovery/reconstitution response time by reducing dependence on manual control procedures and in turn exploiting where possible, proven, operationally oriented, automated and semiautomated processor aided procedures. The prerequisite to automation is a simple man/machine interface which can be backed-up by manual procedures and reliable/maintainable software/hardware packages. Automation will be employed in performing routine functions such as the reliable collection of status and performance data. It will find application in providing coherent, correlated timely system level presentation from which selection of possible control actions can be made.

Inherent in the ATEC equipment to be deployed in the 1980-1984 time frame are system control processing and communications resources. These will be used to preprocess timely data collected from station level sources and to ensure the reliable and accurate transfer of the data. The ATEC derived communications will complement dedicated voice and teletype critical control circuits.

At the theater level, the hardware configuration to support the enhanced control capabilities will consist of a medium size processor interfacing interactive CRT terminals, line printers, tape (128 to 256K bytes), and disk units. The disk unit will maintain applications software and the data base; whereas, the tape unit will be used for start-up, reloading and logging functions. The hardware and software required for the enhancement of the ACOC operational direction capabilities will be an integrated part of the WWOLS planned distributed processing upgrade.

a. Data Base Management Improvement. The data base and data base management system (DBMS) at the theater level will be designed to improve response and effectiveness of the operational functions associated with network, switch/traffic and satellite control. It will interface with the ATEC DMBS, the DSCS Real-Time Adaptive Control and other distributed ADP DMBS.

At a minimum, the theater level data base will contain the following entries: DCS service connectivity, DCS multiplex configuration, and special equipments required to support high precedence communications service. Data base updates resulting from Telecommunications Service Orders (TSO), contingency reconfiguration, or extension requirements will be entered at the theater level as pending changes and then activated into the data base when implemented. Temporary changes in the connectivity (e.g., due to restoral actions, outages, or damages) will be reported via status messages, stored in a status file, and keyed in the data base. Only the latest status information will be maintained in memory. Status information will consist of alarms, degradations in performance, and indications of maximum or near maximum operational capability beyond which degradation can be expected. Circuits and trunks designated for special attention will be flagged for controller alerting (on hard copy printer and CRT displays). All status reports will be logged.

The data base will also contain entries to support switch/traffic and satellite control and to aid correlation of events affecting the connectivity to parameters associated with these controls. For example, routing plans (if fixed) of network switches, interswitch trunk configuration and interconnects with the multiplex hierarchy, mobile subscriber tables, satellite service allocations (frequencies, time slots, power, etc.) and satellite links (modem) to terrestrial tails (multiplex hierarchy) interconnects will be part of the data base. Status changes, reflecting traffic loads, major equipments, alarms, link performance, etc. will be reported up the hierarchical levels and stored in the status file.

The keying of status changes reported from the lower system control echelons will assist in verifying the consistency of the data bases distributed throughout the system control hierarchy and will protect the integrity of the theater WWOLS resident data base from accidental or intentional disruption. Occasionally, theater initiated on-line verification accompanied by acknowledgement of echo responses, as well as off-line audit procedures, will be run to assure consistency of the data base.

The data base management system at the theater level will actively support the management of the Centralized Restoral Plans (CRP). This will involve cross-keying in the data base to the status and a CRP file and the means of alerting the CRP management activity

when a system status change or update has potentially affected the validity of a CRP.

In a time of crisis involving rapid changes in the status of the DCS assets, the entire emphasis of the system control activity will be to maximize communications availability to remaining high priority users. Under these circumstances, accurate and rapid status awareness of available communications resources is of primary concern.

To minimize the processing loads during crisis operation, updates of the data base elements not essential for the operational direction of the DCS resources will be suspended. A subset of the data base consisting mainly of connectivity and resource status will be utilized. The data base management will focus on updates and processing of entries which characterize the go/no-go status of the communications resources.

b. Data Correlation. Correlation of information collected from the terrestrial transmission plant, satellite and switched networks will be performed by the data correlation function at the theater and sector levels. This function will assist in determining cause and effect relationships and possible control responses. The processor based data correlation function will utilize on-line information for short term control activities and off-line information for long-term analysis of subtle system level problems.

The on-line activity will help identify events of traffic congestion, and help relate these events to network connectivity and facility status information. Software packages will be developed to model the DCS and to determine from input status and performance data corrective control responses. The objective in this area is to produce algorithms to verify the effects of potential control actions, prior to actual implementation, and present the most effective control procedure to the controller.

In complex communications systems composed of interdependent switching and transmission subsystems, end-to-end service problems frequently are manifested by the traversal through several interfacing subsystems. Subsystems with diagnostic capabilities detect and isolate problems within the confines of the subsystem. Identification of problems as external to a given subsystem usually results in appropriate notification through the interface between the affected subsystems. Occasionally, service disruption cannot be totally isolated.

The off-line capability will concentrate on the analysis of these unresolved problems. Accumulated raw data or suitably selected condensed raw data will be processed for identifying potential subsystem interface/interoperations problems. The analysis of these may result in improving subsystems interfaces.

c. TOTAL Responsiveness Capabilities. A new data management system, TOTAL, has been adopted at both the worldwide and theater levels of the system control hierarchy and will materially assist the data base management function. TOTAL provides a more flexible data management capability as it treats the entire data base as a cohesive unit rather than a set of independent parts. No time response analysis of the TOTAL system, which uses a link structure for tying together the various parts of the data base, has been made. Usually, the additional bulk memory accesses which are required by this approach result in slower overall data base administration response time. Further experience is needed to determine whether TOTAL is adequate to meet the long term objectives for control response time, which is the subject of the next paragraph.

d. Control Response Time. With the expansion of remote, automated and semiautomated control capabilities, the time interval for issuing outage and degradation reports to the theater level can be reduced considerably compared to current manual practices. A long term objective is to provide information from the reporting level within 2 to 5 minutes of the detection and assessment of major failures. This time interval is estimated to be long enough to filter out transients yet sufficiently short to allow for corrective network control actions. These status reports will provide one of the essential inputs for the theater data base update function, the data correlation function, and the Centralized Restoral Plan activities. Data base updates, revised restoral plans and control directives will be distributed from the theater to all affected levels via the system control communications facilities. The long term objective is to provide a corrective plan (control directive) at the theater level within 15 minutes of the receipt of major communications failure report.

2. SYSTEM CONTROL SURVIVABILITY IMPROVEMENT

The ACOC, though essential for maintaining critical traffic flow is highly vulnerable. Currently, lower elements of the system control levels temporarily assume a portion of the overall ACOC responsibilities using only limited status information and employing mostly manual procedures. The basic objective for this improvement is to enhance backup capabilities to the ACOC. Several key features are deemed necessary at the backup facility(ies). These include: extensive communications interconnection with technical control facilities serving high priority users; processor aided operations and an appropriate man/machine interface. The processor aided operations will rely on the theater connectivity data base, status file and Centralized Restoral Plan (CRP) file. A data base management system will provide capability to relate information and cause updates in the data base and in the files. The status file will focus on reflecting up-to-date go/no-go status of the communications resources.

Three generic alternatives for assuming the ACOC function when rendered inoperational have been identified: the use of the RCOC's and sectors, the use of the worldwide Level or the remaining ACOC's, and the deployment of a separate back-up, survivable ACOC facility within the theater.

The first alternative presents numerous advantages especially in assuming the network control functions of the ACOC. The combination of RCOC's and sectors possess many of the back-up features enumerated above. The extensive lateral communications interconnects among the sectors provide redundancy and graceful degradation of capabilities. This alternative utilizes personnel who are familiar with the theater topology and network control procedures. However, to assume the full amount of network, traffic and satellite control functions of the ACOC, additional data base (or access to data base) and status information will be required at the RCOC/sectors (and rerouting of dedicated status data). Other limitations of this alternative stem from the vulnerability of the sectors especially in the European Theater and the imposed data base within sectors (Sectors maintain the security limitation unclassified portion of the circuit and trunk data base).

The second alternative resolves the vulnerability problem but requires long interconnects, possibly via satellites, to establish communications with RCOC's, sectors and switching facilities and to derive status information. If another ACOC assumes the back-role, duplication and maintenance of an additional theater data base is required.

The third alternative requires extension of communication interconnects to the alternate site. It resolves the vulnerability problem, but the deployment and maintenance of resources and facilities dedicated for back-up operation potentially represents the largest recurrent investment.

Various combinations of the three generic alternatives are also possible. In any event, solutions to the back-up required will be pursued and implemented as part of the System Control improvement.

3. AUTOVON SYSTEM CONTROL IMPROVEMENTS

Of the three major DCS switched networks - AUTOVON, AUTODIN, and AUTOSEVOCOM - the AUTOVON network is the most likely candidate for system control improvements. The present AUTODIN I system control functions are adequate. AUTOSEVOCOM control functions, being almost completely manual, can be improved only at great expense.

a. Improved AUTOVON Controls. Improvement in the AUTOVON traffic and equipment control capabilities will be pursued. The current AECO AUTOVON switches will continue in service for a number

of years past the projected initial operational capabilities (1983 in overseas) of the AN/TTC-39 based voice network.

Current AUTOVON system control capabilities provide for local and remote (from ACOC) controls. In general, AUTOVON control improvements that will be investigated will concentrate on refinements of the local controls and limited expansion of remote control capabilities. For example, the benefit and feasibility of dynamically varying line-load control thresholds as a function of traffic load and traffic load rate of change will be examined. Other potential control improvements to be evaluated include common equipment denial based upon call precedence and traffic loads; extension of trunk directionalization to PBX access lines and possibly remoting of this control to the ACOC. With the advent of the Dual Frequency Signaling Unit (DFSU), the Pilot Make Busy and Manual Make Busy functions will be improved, primarily in that both ends of the trunk can be taken out of service from either end without the current need for voice coordination.

Under certain stress conditions, improvements in network grade of service can be achieved by implementing selective routing table updates from the theater level. This capability will be pursued, although the exact method of implementation will require additional analysis. Expansion of the present capabilities of the network controller to modify switch routing plans by selective cancellation of alternate routes and activation of preselected reroutes to a destination will be examined. For example, precedence dependent routing modifications based upon overall transmission plant status evaluation and traffic loading will be considered.

All local switch/traffic controls will be reported to the ACOC. Theater initiated controls, including routing changes, will be displayed for the network controller.

b. Improved AUTOVON Data Collection. The AUTOVON Centralized Alarm System (ACAS) and the Traffic Data Collection System (TDCS) currently provide two means of collecting and remoting switch equipment status and performance data from the AECO AUTOVON switches. In addition, there is an on-going effort to improve the AUTOVON switch maintenance monitor capabilities and to extend and automatically process the AUTOVON generated trouble and diagnostic data. The processor used to achieve the above improvements potentially can also be used to consolidate and provide call processing and status information, including status of the transmission plant serving the switch.

Information from these systems will be reduced and integrated using processing capabilities incorporated in the station and nodal levels. The data transfer requirements for preprocessed data will

be considerably less than that of raw data. Collection and transfer of raw data will be maintained using present capabilities until no longer needed. The reduced TDCS data will be combined with the ACAS information and transferred to the theater level over available ATEC communications resources within the nodal and sector levels. Transmission related diagnostic data information will be initially evaluated against the ATEC transmission testing and fault-isolation capabilities to determine whether it is useful, non-redundant information. Based upon that determination, a decision will be made regarding the continuing extraction of diagnostic data for use outside the local facility.

IV. SYSTEM CONTROL SUPPORT FOR EVOLVING DCS PROGRAMS

The advent of AUTODIN II, AUTOSEVOCOM II and DSCS III will mark the employment of subsystem and equipment designs which incorporate the operational and management requirements of system control. The present AUTOVON, AUTODIN I and the existing transmission plant require various add-on equipments and retrofits to provide system control data. However, the trend in the development of new DCS subsystems has been to include, in the original designs, the means to extract and transfer operational data and receive, accept and implement control directives on a timely, semiautomated or completely automated basis. These provisions will increase the effectiveness and flexibility of monitoring, assessing, and controlling new DCS resources. As a result, shorter response time in reaction to crises management needs such as reconstitution, and interoperability with tactical communications in support of the Joint Multichannel Trunking and Switching System (JMTSS), is attainable. In the case of the switched networks, telemetry and control channels have been specified to collect appropriate data and apply controls directed by remote system control facilities. Similar interface with the digital transmission subsystem is in the planning and design stages. Plans for DSCS Real Time Adaptive Control and requirements to interoperate with tactical control elements point out the need for timely exchange of information and control messages across the respective system boundaries. The following paragraphs describe system control system interactions with each of the planned DCS subsystems. Procedures and means for interfacing the tactical control elements are described in reference /16/ and, therefore, are not addressed here.

1. SYSTEM CONTROL FOR AUTOSEVOCOM II - GENERAL DESCRIPTION

Since the design and architecture of the AUTOSEVOCOM II has not been finalized, the description provided below represents a preliminary approach for the AUTOSEVOCOM system control.

The AUTOSEVOCOM II network will employ in CONUS a leased analog based network with government owned Key Distribution Centers and local switches. The leasor for the CONUS portion of AUTOSEVOCOM II will provide fault-isolation, maintenance service, restoral and routing control. The government involvement will be generally limited to coordination of circuit rstoration and receiving status and performance reports for management purposes. Similarly, traffic flow control, traffic routing, facility, and configuration control of the leased switches will be established by the leasor with the government receiving appropriate summaries of status and performance information. Unit Level Circuit Switches such as the SB 3865 or AN/TTC-42 which are being developed for tactical operations may serve as the access area switches. These switches provide status alarms and diagnostic information to the local technical control facility or

maintenance center. Summaries of these data and traffic related data will be relayed to the DCAOC over common user switched networks.

Overseas the AUTOSEVOCOM II network has been projected to consist of GFE AN/TTC-39 switches and Unit Level Circuit Switches (ULCS), and mostly government-owned transmission plant. Interaction with system control will involve theater, sector and nodal resources. Transmission related status will be reported to the nodes and sectors. To assist the network/switch controllers, switch major alarms and problems will be relayed to the ACOC on an occurrence basis. The ACOC will be able to query and receive traffic and call data as required. Scheduled (periodic) reporting of call and traffic data will be provided for management, planning and traffic engineering functions. The ATEC based communications resources will be used to forward data and control messages to and from the switches.

a. System Control Interface with Unit Level Circuit Switches (ULCS). The ULCS's being considered provide traffic, maintenance and diagnostic data including trunk, access line and subscriber terminal status to the local supervised maintenance position within the switch. For example, the SB 3865 (see reference /15/) will measure and record the following traffic parameters: total number of originated loop calls (precedence and routine); number of calls preempted per trunk group; and number of All Trunk Busy (ATB) conditions. In addition, extensive diagnostics, self tests, alarms (power, environmental controls, timing subsystem, etc.) and loop and trunks go/no go status are available locally. The ULCS supervisor/maintainer facility will enable the local personnel to issue and effect commands through appropriate man-machine communication. Acknowledgment indicates the recognition, acceptance and execution of commands. The sets of commands include loop, trunk, trunk group and multiplex group configuration selection, removal from service (off-line), and parameter changes. The command also enables change of threshold including reporting thresholds, acknowledgement of alarms, system recovery, restart, startup and shutdown, entering information for routing tables, classmarks, etc., initiating loop-back tests for loops and trunks, resetting of timing buffers and reading and resetting traffic meters.

The SB 3865, unlike the AN/TTC-42, does not provide an external interface to the above data outside the local facility. Hence an external communications interface with the system control levels is required. This interface will transfer status and performance information from the ULCS and control directives to the local switch controllers. A 150 b/s line will be sufficient to carry the traffic, status and control directives. Overseas this communications line will interconnect the ULCS with the nodal subsystem. The node, in turn, will receive and decode the messages and extract the transmission related information. The information will be used to

correlate transmission related problems with transmission information derived from other sources. Traffic data will be routed directly to the ACOC through the sectors. At the ACOC the traffic information will be processed for long term planning and short term control functions. The sectors will receive, display and store appropriate transmission information in support of their control and management functions. The ATEC error control techniques will be used to enhance reliability of data and control message transfers.

In CONUS, the 150 b/s communications interface can be realized as a dialed-up system over the common user switched network.

b. System Control Interface with AN/TTC-39. Within the CCIS overhead channel structure associated with each trunk group of the AN/TTC-39, up to two 2 kb/s subchannels have been allocated for system control purposes. These subchannels will be used to convey switch, circuit, and traffic status including the following indications: congestion by trunk groups; common equipment availability; switch equipment and trunks status; loop test results and trunk performance (error rates on trunks); and various circuit switch traffic statistics. Additional reports relating to validation of reports and directives, acknowledgement of directives, notification of local traffic control applications, notification of local data base updates, and notification of local parameter threshold modifications will also be reported over the system control subchannels. The system control subchannel will also serve to transmit control messages from the system control subsystem to the switch. These messages will direct the switch concerning the type and duration of metering to be performed; type and frequency of reports; trunk traffic controls including trunk load control, trunk restriction, and traffic directionalization; and traffic control through data base table modifications including routing updates, modifications of class mark table, parameter threshold, and directory lists update for mobile subscriber. Other traffic control directives include lock-out message, zone restrictions, call inhibitions, and alternate area routing. The control messages will also be able to direct the type of traffic statistics to be collected. These reports and directive messages constitute collection of the TRI-TAC TCCF report and directive message protocols, as defined by TRI-TAC Document #ICD-004.

The theater level will be capable of generating any of the control messages described. These will be routed through the associated sector and node to the designated switch. Directives will be stored and displayed at all participating control levels until an implementation message is received from the switch.

All reports in response to directives initiated at the theater level will be forwarded to that level via the nodal and sector facilities. Transmission status reports and trunk performance

reports will be processed at the node and sector levels and summaries of these will be sent to the theater level. Reports of hazardous conditions, traffic statistics, traffic composition reports and local modification of tables and data bases will be relayed to the theater level. Notices of traffic control and network control implemented by the switches will also be transmitted to the theater level.

The physical interface with the system control subchannel will be at the nodal facility. These signal conversions and the message decoding will be performed to achieve compatibility with the intrasystem control signals and protocols and to provide message error controls.

c. O/S AUTOSEVOCOM II/Technical Control Facilities (TCF) Interface. The TCF interface with the AN/TTC-39 and ULCS switches is yet to be fully defined. Analog circuits (trunks and loops) configuration at the TCF will be similar to the present AUTOVON/TCF configuration. Fixed time division multiplexers will provide digital group and channel appearances at the TCF. Circuit reroute and restoral will be performed manually. Eventually, programmable patching devices will be utilized to provide trunk and loop and multiple trunk group patching based on a time slot (channel) interchange.

2. SYSTEM CONTROL INTERACTION WITH AUTODIN II

As the overseas packet switched network evolves, it is assumed that basic system control information will be derived through the capabilities of the AUTODIN II Network Control Center (NCC). Initially system control packets will be routed over transoceanic trunks to the NCC at the DCAOC. As the system matures, each ACOC may be configured to provide NCC capabilities to the AUTODIN II switches within its theater of operations. AUTODIN II system control information exchange among the control centers will be properly secured.

3. INTERFACE OF SYSTEM CONTROL WITH THE DSCS REAL-TIME ADAPTIVE CONTROL (RTAC) SYSTEM

The Defense Satellite Communications System (DSCS) in the 1980-1990 time frame will offer its subscribers (both DCS and non-DCS) long-haul transmission media featuring enhanced operational and resource allocation flexibility compared to other long-haul media. This capability will be implemented by the DSCS Real-Time Adaptive Control (RTAC) system and the DCS System Control/RTAC interface.

RTAC is a three-level hierarchical control subsystem lying within the overall DCS system control hierarchy. It consists of the

Operations Control Element (OCE) at the worldwide level, the Network Control Element (NCE) at the satellite network level (determined by each satellite's coverage) and the Terminal Control Element (TCE) at the earth terminal level. These interface the system control levels at the worldwide (DCAOC), theater (ACOC) and nodal levels, respectively.

The subsequent paragraphs describe these interfaces. However, it should be noted that this area is still in the formative/conceptual stage and under continuing study. Only general approaches for the interfaces in terms of functional support information flows and communication needs are given.

a. System Control Worldwide/Operation Control Element (OCE) Level Interface. System control at the DCAOC level and the RTAC Operational Control Element primarily support management, engineering and planning activities. Thus, the interactions between these two elements will include support of network management functions including limited circuit planning, origination of contingency plans, network level performance status monitoring and periodic performance status reporting.

The OCE will receive satellite performance summaries including satellite throughput capacities and allocation of capacities for both DCS and non-DCS users. It will acquire summaries of the DSCS networks' performance which will include link status, quality indicators and utilizations. The OCE will access the worldwide data files of the satellite channel allocations, link connectivities, and satellite network resources. The data files will be accessible to the system control worldwide level which will maintain the worldwide users' connectivity and requirements data base. The OCE status and performance data will also be available for correlating and tracking total DCS network status and performance.

The current approach for interfacing the worldwide system control level and its associated WWOLS system with the OCE, calls for a single computer complex facility that will combine the processing, I/O resources and data bases of both control elements. The facility will also provide processing support for display and data base access/update functions. The OCE unique equipments will consist mainly of man/machine interface hardware and software capable of supporting data base queries/updates, message exchanges and displays. Similar man/machine devices will be available at the lower RTAC control levels.

The combined worldwide control facility will receive periodic status and performance summaries derived from data exchanges across the interface of the subordinate system control theater level and RTAC Network Control Element. Low rate digital links (150 b/s), carried over the satellite will meet the interface communications

requirements. Communications via the AUTODIN network will complement and back up the satellite link.

b. <u>Theater/Network Control Element (NCE) Level Interface</u>. The theater/NCE interface will support both management functions and network and transmission control functions associated with the theater level. The NCE will provide satellite status data and satellite link performance data. That data will be correlated at the theater level with relevant terrestrial transmission data and DCS user traffic requirements to determine the quality and availability of the network within the theater. Information exchanges between the theater level and NCE will serve the theater functions of maintaining and updating the theater circuit connectivity, issuing reconfiguration directives and controlling and scheduling satellite traffic loading. The capability of the NCE to perform timely allocation analysis and training evaluation will improve response to contingencies requirements. The NCE will report to the theater on satellite transponders, earth stations, and satellite link failures or degradations and will provide estimated downtime, reason for the outages or degradations, and changes in previous status. From these, needline status will be determined. Furthermore, the NCE will report on jamming conditions, satellite loading status and changes to loads, and traffic summaries on demand assigned services. The NCE will also provide the theater status and connectivity of non-DCS satellite users. The theater will issue directives which will be confirmed by the NCE. The theater level will also inform the NCE of relevant DCS outages and associated downtimes. The theater will maintain and control the intra-theater and designated inter-theater connectivity data base and will translate satellite connectivity data (DSCS channel, earth terminal, modem, etc.), maintained by the NCE, into DCS connectivity information (station, links, groups, multiplexer, and circuits).

The connectivity between the four DSCS NCE's and the three DCS theaters is shown in Figure 4. For each satellite network, the theater control will interface directly with either the active or backup NCE by means of a dedicated 2400 b/s data link. Connection to the remaining NCE will be established via an additional 2400 b/s inter-theater data link.

c. <u>Nodal/Terminal Control Element (TCE) Level Interface</u>. The node/TCE interface is required in the implementation of operational control directives in testing and monitoring of operational equipments, and in detecting and isolating transmission faults.

The Technical Control Facility associated with an earth terminal will interact with the node as a station facility. The TCE will be a major control interacting component of the TCF. The TCE will automatically report any satellite link outage or degradations as indicated by local equipment alarms (modems, etc) and link

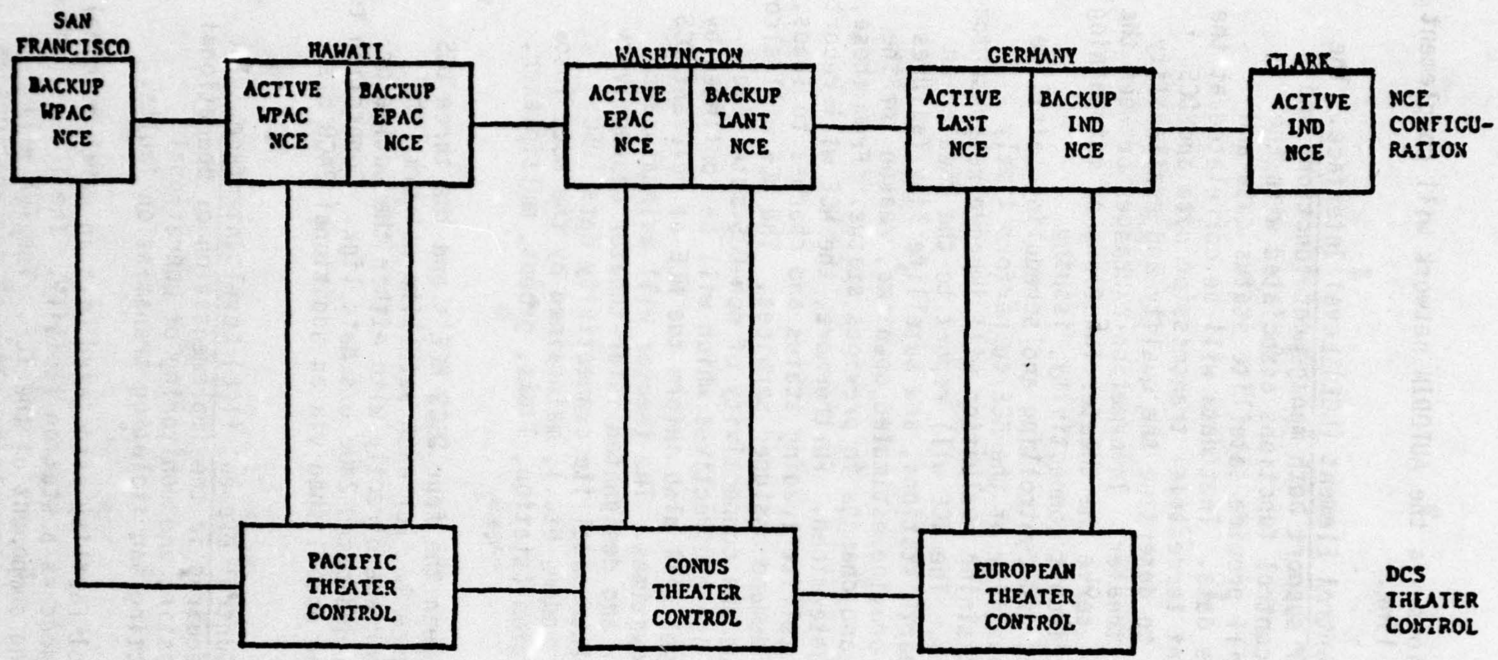

FIGURE 4. THEATER CONTROL/NCE INTERFACE CONNECTIVITY

performance monitors. The nodal level will maintain the data base necessary to identify DCS circuits traversing the nodal areas which are supported by the satellite links. The TCE will coordinate with the nodal element to determine whether faults originated within the satellite system. Faults within the satellite system will be isolated by the RTAC system and results reported to affected ACOC's. Coordination in support of TSO and circuit restoral directives will take place between the node and the TCE. In addition, coordination will involve implementation of network reconfigurations and modifications of traffic loading to support efficient DCS resource allocation. All communications between the TCE and the node are intended to be via 150 b/s. ATEC protocols, message formats and message acknowledgement procedures will be utilized. Automatically reported data, as well as query and response activities, will involve direct TCE processor to nodal processor interface with appropriate displays at the TCE and TCF controller terminal positions. Coordinations will involve non-processor interfaces at the station level.

V. SUMMARY AND CONCLUSIONS

This report has presented a top level view of the planned improvements for the DCS System Control during the 1980-1985 time frame. These improvements aim at making the DCS control hierarchy more responsive and reactive to management and control requirements, especially during crisis and war times. Concurrently, these improvements strive to attain efficient, peacetime management and control operations. The improvements under consideration consist of:

a. Upgrading the theater level management control and operational direction functions by expanding the capabilities to process, correlate and present to the controllers for decision making, relevant and timely information derived from multiple sources.

b. Enhancing the survivability of the theater level functions.

c. Upgrading switched network controls and improving utilization of circuit switch resident information for control and management functions.

d. Enhancing the WWOLS ADP and data base management capabilities to interface lower system control level ADP systems.

e. Providing the system control interfaces and interactions with planned DCS subsystems.

The plans introduced in this report will serve as the basis for the System Control improvement program. Implementation of the program will take place in a step-by-step evolutionary manner with each step thoroughly analyzed for feasibility, costs and operational impact.

REFERENCES

/1/ DCAC 300-50-6, Policies - "System Control of the Defense Communications System," 24 June 1977.

/2/ DCAC 310-50-5, "DCA Operations Control Complex and Operational Direction over the DCA," 7 November 1977.

/3/ DCAC 831-70, "DSCS Phase II Standard Operating Procedures," (DRAFT).

/4/ DCAC 310-65-1, "Circuit and Trunk File Data Elements and Codes Manual of the DCA," 11 June 1976.

/5/ DCAC 310-55-1, "Operational Direction and Status Reporting for the Defense Communications System," Vol I July 1972, Vol II January 1977.

/6/ DCAC 310-65-2, "DCS Circuit Allocation and Engineering Manual," Vol 1, Methods and Procedures.

/7/ DCAC 310-V70-44*, "Overseas AUTOVON Network Control Procedures," August 1972.

/8/ System Specification for Automated Technical Control (DRAFT), June 1977.

/9/ DCA Concepts of Operations for Automated Technical Control (ATEC) 14 June 1978.

/10/ Final Report, System Control Inc., DCA Contract No. 100-75-C-0052.

/11/ DCA 100-76-C-0092, "Unified Network/Traffic Transmission Media Control," August 1977.

/12/ Draft Working Paper, 18 February 1977, MITRE Corp., ESD Contract No. F19628-77-C-0001, "Strawman for a Phase I DCS System Control Capability," J. C. Shulstad.

/13/ DCEC TN 5-75, "System Control Alternative Analysis," April 1975.

/14/ DCA 100-75-C-0062, "Definition of Real-Time Adaptive Control (RTAC) of the DSCS," 30 August 1976.

/15/ Specification No. TT-B1-1203-0033, 11 May 1976, Performance Specification, Automatic SB-3865( )(P)TTC.

/16/ Chapter 20, "Recommended Parameters and Procedures for System Control and Management of Military Communications Systems," 27 June 1978.

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